Project Title: Carbon Effects on Nitrogen Retention and Nitrogen Transforming Microbial Populations

Investigators: Scott M. Holub (USEPA/ORD/NRMRL/GWERD; Ada, OK 74820; Holub.Scott@epa.gov)
R. Gunadassa Silva (Oak Ridge Institute for Science and Education, Oak Ridge, TN 37831)

Introduction to the problem: The addition of nitrogen to ecosystems through intentional fertilization or unintentional atmospheric deposition from fossil fuel burning can lead to unhealthy levels of nitrogen in rivers and groundwater. Excess bioavailable nitrogen has many harmful effects on the environment and human health. If nitrogen inputs can not be reduced, then other methods of preventing nitrogen from reaching surface or ground water need to be explored. To better predict the effectiveness of ecosystem restoration methods a more thorough understanding of the intricate relationship between carbon and nitrogen cycling is needed.

Background: Soil microbes influence the cycling of nitrogen and carbon in terrestrial ecosystems through their role in organic matter decomposition and nitrogen transformation. A better understanding of how soil microorganisms respond to excess nitrogen is necessary to plan restoration methods to reduce nitrogen leaching. Microbes are widely believed to be limited by carbon availability, so additions of carbon in areas with high nitrogen availability have been proposed to increase nitrogen uptake by microbes. However a growing number of studies have shown that microbes are sometimes limited by nitrogen, which prompts further research, because if carbon is not limiting microbes in some situations then carbon additions might not result in a reduction in nitrogen leaching.

Objectives: to determine the effect that carbon additions have on nitrogen retention and nitrogen transforming microbial populations. The results of this study will provide needed scientific information regarding the potential use of carbon additions to restore and protect water quality and limit nitrogen leaching into streams and waterways.

Approach: A factorial design with three levels of ammonium chloride (0, 100 and 1000 kg N/ha), and two forms of carbon (glucose and tannic acid), each with three levels (0, 100 and 1000 kg C/ha) has been replicated three times at each of two old-field sites in southeastern Oklahoma. One site at the Center for Subsurface and Ecological Assessment Research (CSEAR) site near Gaar Corner, Oklahoma has a clay soil and the other is on a sandy soil at the Tishomingo National Wildlife Refuge, near Tishomingo, Oklahoma. Tracer levels of ^{15}N-ammonium chloride were also added to half of each plot to calculate total nitrogen retention. Soil and plant samples are being collected on eight dates over a six month period. Soil samples will be analyzed for total aerobic microbes, denitrifying microbes, and ammonium oxidizing microbes using the most probable number (MPN) method. In addition soil samples will be analyzed for total carbon, total nitrogen, NH_4^+, NO_3^-, and soluble organic carbon using in-house established methods. Soil respiration will be measured in the field plots using a LiCor 6400 system.

Accomplishments to date (Oct 2005): All samples have been collected. Preliminary results were presented as: Holub, S.M., R.G. Silva. (2004). Carbon quality and quantity affect the retention and microbial processing of applied nitrogen. Oral Presentation Abstract for the Ecological Society of America Annual meeting in Portland, Oregon.

Two papers in preparation/peer review from this work.

Near future tasks: Data analysis and publication of results in a peer reviewed journal.